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Research Article

IoT-Based Solar Energy Measurement and Monitoring Model

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In the early days, greenhouse energy did not pay much attention to coating inspections and new applications, spending more attention on repair solar energy projects instead. However, these attitudes have recently changed. Energy producers realize that preventing corrosion and deterioration is less expensive than solving the greenhouse problems when they occur. The proposed model also provides coating, paint control, and error analysis services within the scope of solar machinery and equipment-related services while the greenhouse equipment reached a low energy level. The greenhouse monitoring services ensure that a solar plant is economical, reliable, and of high quality, meets legal requirements, conforms to standards published by domestic and foreign organizations, and determines conditions that cause short circuits or power outages. In this context, with the help of cloud computing-based Internet of things (IOT), the industrial power stations, high-voltage substations, low-voltage networks, power stations that comply with legal regulations on safety from electricity, electrical installations for machinery, alarm systems, fire alarm systems, cathodic corrosion protection mechanisms in oil tanks and pipelines, emergency power supply installations, electrical installations in buildings, and gas alarm systems are inspected and documented.

1. Introduction

The biggest advantage of solar energy systems is that they do not have negative effects on the natural environment like renewable energy sources such as wind, hydraulic, and geothermal. The fuel of solar cells is solar energy and this energy costs nothing [1]. Also, it does not pollute the environment. In recent years, research has been done on solar-powered vehicles in the automotive industry and many other applications like solar still and so on [2]. Today, these cars have limited power; although they are single-seater vehicles, the speed of the vehicles is 40 kmph. However, it is still not suitable for daily use in today's traffic flow. Nevertheless, in today's conditions, developed and developing countries continue their research and development studies [3, 4]. A shared understanding of the significance of the social decisions society must make regarding energy sources, production, and environmental effects. The organization conducts vigorous

debates on global petroleum production and consumption patterns. Debates are now intensifying as to how long the world's crude oil reserves can be used and what alternatives can be used after they are exhausted. Scientists are devoted to finding alternative arrangements for future energy needs. In our country, research is being done on solar-powered vehicles, electronic devices for lighting, and heating devices. Electricity market regulation is enacted to increase the use of renewable energy sources [5]. This regulation regulates the principles and obligations for language practices in the electricity market. This framework also includes incentives for renewable energy sources [6]. Considering the increasing energy demand and solar energy potential of our country, it is necessary to accelerate efforts in this direction. Final Installation Inspection Energy Services for companies operating in the solar energy sector are inspections to prove that the installation and connections are in compliance with all requirements before commissioning solar energy facilities [7, 8]. The major problem with extracting oil from the Macal rocks is that it is not currently profitable if overcome. The energy it costs to extract it is more than what can be obtained from it. It is a situation where income is not met and expenditure is not met. Natural gas molecules are stuck to the rocks in the mantle layers. Only by squeezing them will they come to the surface. It is a complicated and costly process. As oil prices skyrocket, governments and oil companies are turning their attention back to methods previously abandoned as unaffordable. Interest in drilling oil wells on deep sea floors has increased. Since the discovery of oil in the North Sea region north of England, around 40 billion barrels of oil have been produced from oil wells there.

Solar energy is an energy source that does not pollute the environment, requires no external dependence, and is considered free. It is one of the leading renewable energy sources. Previously used in daily life and residences, solar energy has gradually expanded to agriculture, communication, industry, military services, and power generation [9]. Theoretically, solar radiation can be used in all areas of life. In a simple calculation, the amount of energy coming from the Sun in a year corresponds to 50 times the known coal reserves and 800 times the oil reserves [10]. In this respect, the solar energy source will occupy a very important place in the future. According to estimates, by 2050, 11 percent of the world's electricity generation will come from solar energy [11]. Currently, the amount of electrical energy obtained from solar energy is increasing by about 20 percent compared to that of the previous year. In this regard, countries like Germany, Italy, and Czech Republic are leading in production [12]. The share of these three countries reaches 70 percent. The good news is that our country has more solar energy potential than any other European country except Spain. In this regard, our country should adopt consistent and applicable policies for generating electricity using solar energy [13, 14]. At this point, manufacturing companies have a lot of work to do. Regardless of where they operate in the world, it is important to evaluate vendors and suppliers with an independent and unbiased perspective [15]. The ability of these companies to comply with the terms of the contract and meet certain standards and legal regulatory obligations can only be achieved through the work to be carried out by authorized companies [16]. There is an urgent need to find alternative sources of energy. Besides the increased cost, the impact on the environment is also a concern. Burning fossil fuels produces 21.3 billion metric tons of carbon dioxide annually. About half of it is occupied by plants and oceans. The remaining carbon dioxide is increasing the global warming and increasing the surface warming. Efforts are also underway to extract hydrogen gas from seawater and rocks. It is an ion that can provide energy without polluting the atmosphere.

Crude oil processed in refineries is approximately 43 percent gasoline, 18 percent fuel oil and diesel, 11 percent LPG (a mixture of liquefied petroleum gas, propane, or propane-butane), 9 percent jet fuel, 5 percent asphalt, and 14 percent other oil [17, 18]. Products are received. All these manufactured goods are transported by sea, road, and pipeline depending on the conditions [19, 20]. In the transportation of produced energy resources, disputes between the parties are likely to arise if the product does not conform to the terms of the contract or standards or is not accepted by the buyer for any other reason [21–30]. Energy resources are naturally occurring sources of energy for humans. It is a known fact that we need energy to do any work. We get the energy that we need to meet our daily needs from energy sources. Energy resources are generally divided into two broad categories, namely, renewable energy resources and nonrenewable energy resources. Renewable energy sources include solar, wind, hydro, geothermal, and biomass. Petroleum products, natural gas, coal, and fossil fuels are nonrenewable energy resources.

2. Literature Review

In parallel to the increase in human population, the world's demand for electrical energy is also increasing. For this reason, turning to renewable energy sources has become inevitable. Our country is completely foreign dependent for its energy needs [21]. As efforts are being made to use existing energy more efficiently, the search for new sources of energy continues. Among the renewable energy sources, solar energy is the most significant and widely used resource in recent years. Setting up solar farms or solar power plants are big projects [22]. For these installations carried out by the tender, the companies authorized by the tender offer support for the preparation, conduct certain tests and analysis, and negotiate the terms of the contract [23]. On the other hand, high levels of fossil fuel consumption, depletion of the ozone layer, effects of global warming, and the increase in greenhouse gases as current energy resources have reached a depleting state are forcing countries to seek new energy sources [24]. Renewable energy resources are resources that can be regenerated by the environment in a short period of time. These resources are obtained from natural sources like the Sun, wind, rain, and sea. From these sources energy can be drawn repeatedly at times of need. Renewable resources are abundant in nature. And when energy is obtained from these sources and used, they often do not harm the environment. For example, electricity is generated from the energy obtained from sunlight. In this way, the energy for our daily

needs is obtained from the resources of wind, geothermal energy, and wind and ocean waves.

As researchers work to make more efficient use of existing energy resources, the search for solutions for renewable energy sources continues [25]. Solar energy is one of the renewable energy sources and our country can be considered lucky in this regard. A lot of progress has been made in the world and in our country in getting electricity from solar energy [26]. Additionally, our nation has more solar energy potential than it can use to produce electricity. We are increasing public awareness of the issue and introducing new producer incentive programs [27]. Research on obtaining electrical energy from solar energy is progressing rapidly, but it is a fact that quality studies should not be neglected at the production stage. In this regard, the importance of unbiased and independent services provided in this direction by recognized organizations is high [28]. Nonrenewable energy resources are resources that cannot be regenerated by the environment in the short term. These resources are obtained from beneath the earth. These resources will disappear in fifty or sixty years. These cannot be renewed in a short period of time. Nonrenewable resources are limited to a certain amount. When we extract energy from these sources and use them, they emit large amounts of greenhouse gases. This causes environmental pollution.

3. Proposed Model

Semiconductor solar cells or photovoltaic cells are used to generate electricity from solar energy. Photovoltaic cells are also called solar cells. These batteries generate equal positive and negative charges from the photon energy that they reach and convert solar energy directly into usable electrical energy. Many different materials are used in the construction of solar cells. Semiconductor materials such as amorphous silicon, crystalline silicon, cadmium telluride, and gallium arsenide are often used. The most widely used of these is silicon, which is the most common in nature. Utilization of energy resources is essential as human survival and progress depend on the earth's energy resources. The extraction and use of energy from energy sources has serious effects on the environment. Therefore, energy should be used sparingly to reduce the impact of severe environmental impacts. And the dwindling nonrenewable resources must be conserved for the use of future generations. Better research and development are necessary to make full use of renewable resources.

The Sun's rays reaching the solar panel transfer electrons to the semiconductor technology in the batteries, resulting in electricity. Solar cells are durable, nonpolluting, and long-lasting devices. There is no electrical problem when they are working. Also, they do not require much maintenance. Batteries in the modular structure are connected to each other in series and parallel. Depending on the structure of the battery, solar energy is converted into electrical energy, which is currently 20 percent efficient. However, the batteries are enabled to follow the Sun, using methods such as maximum power monitoring based on sunrise and sunset times and methods such as temperature protection and air conditioning to try to achieve maximum efficiency. Unnecessary lights and fans can be turned off. This reduces electricity bills and indirectly prevents environmental pollution. Use of public vehicles can be used to reduce the use of private vehicles for transportation. Each of us will use energy resources sparingly where necessary to protect the environment and achieve economic self-sufficiency. Keeping track of production activities is important here. Authorized companies provide visual control services at production levels. After replacement or manipulations to increase the density of the electrolyte, a solution with a different indicator is installed in the solar photovoltaic cell banks. A gap in the range of 0.01 g/cu.cm is allowed. See, to equalize this value, that a corrective recharge is required. The essence of the method is to provide current for 1–2 hours while charging 2–3 times less than the nominal value. In the absence of a positive result, intensive rehabilitation methods are used. Charging is applied by devices equipped with regulators that provide a constant voltage at the input. The procedures for restoring density by corrective charging were shown in Figure 1:

(i) The solar photovoltaic cell is fully charged

(ii) At the moment of reaching the maximum charge when observing the boiling point of the electrolyte, the current strength decreases to 1–2 A

(iii) During the boiling process, the filtrate evaporates and the density of the liquid increases

(iv) For each individual case, the evaporation time may be different and sometimes reach 1 day

(v) As the density decreases below 1.25 g/cu.cm electrolyte which is added, the concentration is measured when the device cools down to 25°C

Renewable energy is energy that can be regenerated by the environment in the short term. This type of energy is obtained from natural sources like the Sun, wind, rain, sea, and earth. Renewable energy technology includes solar energy, hydroelectricity, wind energy, biomass energy, and biofuel energy. Renewable energy is often used for everyday activities such as electricity generation, water heating and cooling, and transportation. Renewable energy is derived from nonrenewable sources. And this kind of energy does not cause much harm to the environment. So, this type of energy is considered important these days. The Sun is the world's largest source of energy. Solar cells are used to generate electricity from the Sun without using any moving parts and without harming the natural environment; they silently convert the Sun's rays directly into electrical energy. Hence, it provides a clean source of energy. Solar cells last longer than other electrical energy-generating systems. When generating electricity from solar energy, photovoltaic systems are installed. In these systems, photovoltaic cells are connected in series or parallel to obtain high voltage, current, or power. Photovoltaic panels are numerous photovoltaic modules connected by electrical cables. Pipelines are generally used to economically transport liquids and gases

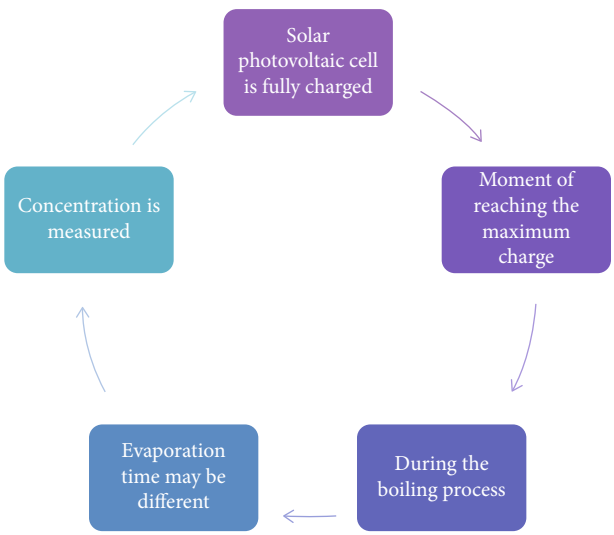

Figure 1: Procedures for restoring density by corrective charging.

over long distances. Generally, pipelines transport petroleum products such as crude oil, gasoline, diesel oil, and jet fuel and concentrated solids such as natural gas, sludge, and treated water. Pipelines were first built to transport oil from large oil fields. Today, it is mainly used to transport natural gas. The Sun is the source of many sources of renewable energy. Solar energy is the energy obtained directly from the Sun's light and heat. The Sun is the indirect source of energy for wind, water, and life. The energy obtained from the Sun is used directly to generate electricity and to heat and cool water. We use only a fraction of the energy that the Earth receives from the Sun for renewable energy. Although the first pipelines were made of wood, with the development of technologies over time, steel pipes started to be used. Today, pipes made of thinner but higher strength materials are used. The following procedures essential during pipeline construction were shown in Figure 2:

(i) Opening pipes

(ii) Placing pipes

(iii) Welding

(iv) Nondestructive testing

Welding is a very important process in pipeline construction. The safe and quality operation of the pipeline for many years depends on it. Control and inspection services of solar energy systems provided by recognized companies and postproduction, nondestructive testing services are also available. Nondestructive testing is a type of inspection performed without damaging the entire object or parts. The validity of this test is based on the results of previous destructive tests. The key here is nondestructive inspection of systems and equipment. Wind blows due to solar heating and Earth's circulation. The energy released when the wind blows is stored and generated by wind turbines. The method of storing and using wind energy is less polluting than the method of obtaining energy from

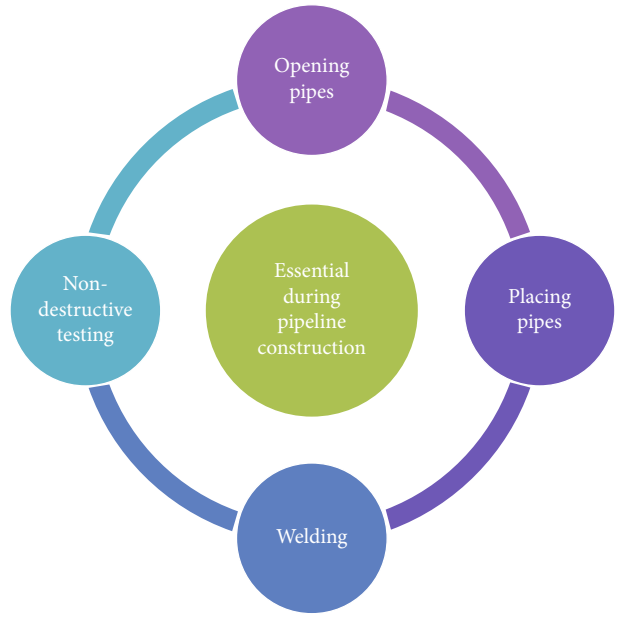

Figure 2: Essential during pipeline construction.

other energy sources. India ranks fourth in the world in generating electricity using wind energy. Before using correction electrolyte, it is necessary to implement the procedure shown in Figure 3:

(i) Some fluid is removed from the repaired cell

(ii) Now, it is necessary to add exactly the same amount of correction electrolyte, which will increase the density

(iii) Also, the photovoltaic solar cell is charged with a rated current by a constant device, which contributes to the mixing of fluids

(iv) After half an hour of charge, the solar PV cell should "rest" for 1–2 hours (this is necessary to equalize the density in the cell)

(v) The measurement is repeated, and if necessary, acid correction electrolyte is added again, but in smaller quantities

Hydroelectricity is the process of generating electricity using the kinetic energy of water due to the gravity of the earth. No solid waste or greenhouse gases are released in this energy generation process. Hence, hydropower occupies an important place in renewable energy. It is an extreme step when its resource is reduced to g/cu.cm by electrolyte and its resource is completely depleted. See that the steps are carried out in the following order shown in Figure 4:

(i) After preparation, the solar PV cells are completely removed from the solution from the cans using a pear

(ii) If the solar photovoltaic cell is turned on its side, it is necessary to drill holes with electrodes in the

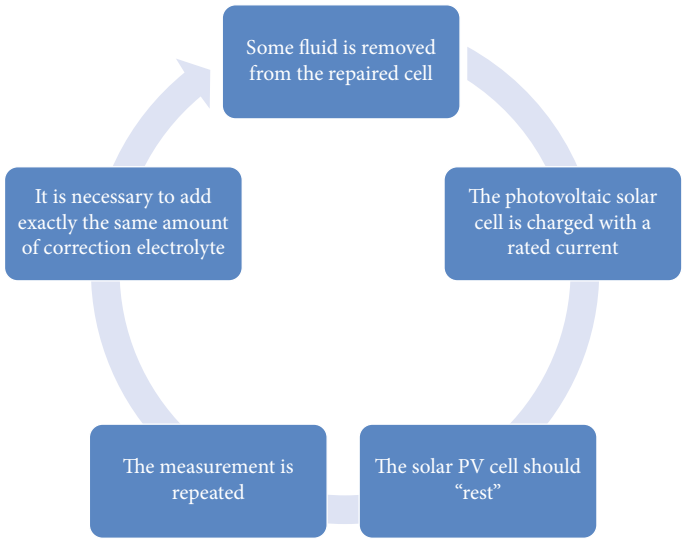

Figure 3: Necessary to implement the proposed procedures.

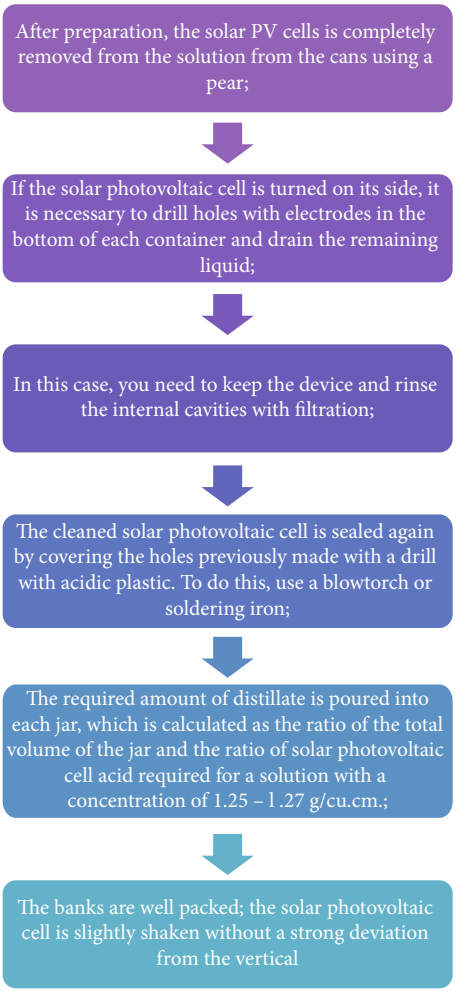

Figure 4: Reduced resource management.

bottom of each container and drain the remaining liquid

(iii) In this case, you need to keep the device and rinse the internal cavities with filtration

(iv) The cleaned solar photovoltaic cell is sealed again by covering the holes previously made with a drill with acidic plastic. To do this, use a blowtorch or soldering iron

(v) The required amount of distillate is poured into each jar, which is calculated as the ratio of the total volume of the jar and the ratio of solar photovoltaic cell acid required for a solution with a concentration of 1.25–1.27 g/cu.cm

(vi) The banks are well packed; the solar photovoltaic cell is slightly shaken without a strong deviation from the vertical

The solution must first be drained from each solar photovoltaic cell can. Then, fill with new liquid with a density of 1.25–1.27 g/cu.cm. After filling the jars to the "norm" mark, tightly close the lids and shake the solar photovoltaic cell a little. Do not turn the battery upside down. With such handling, pieces of lead salt can break off from the grid and move to the nearest electrode, causing the jar to close. After that, the damaged container becomes unusable. Concentration readings will prompt the need to repeat the electrolyte replacement procedure. If the indicator is below 1.25 g/cu.cm, see that the operation must be repeated until the desired result is obtained.

4. Results and Discussion

The proposed greenhouse solar energy monitoring (GHSEM) model was compared with the existing optimized

greenhouse environment and resource management (OGERS), demand side management of energy consumption (DSMEC), an optimization scheme for IoT (OSIOT), and photovoltaic spectrum performance analysis (PSPA).

4.1. Pipeline Integrity Tests. In this regard, pipeline integrity tests, i.e., insulation and cathodic tests and welder qualification tests carried out by recognized organizations, are of great importance. Welder qualification surveys are aimed at evaluating welder personnel of pipeline operators or supplier companies involved in pipeline construction. The comparison of pipeline integrity tests is demonstrated in Table 1.

Poor quality welding or incomplete or inappropriate welding procedures in pipes are the main reasons for the poor and unqualified welding process, premature failure, and unnecessary costs.

4.2. Design Review and Inspection. It is an engineering method performed by recognized organizations during design inspections of products. Design review is one of the most important steps in delivering a high-quality product. Basically, auditability is a design feature that expresses how easily an audit task can be created. Studies are studies that define how specific properties of a material are obtained according to the designed properties. In other words, the purpose of the investigation is to determine whether an operation has been performed or to make standard measurements or observations that will show whether the operation has been performed correctly. The comparison of design review and inspection is demonstrated in Table 2.

4.3. Design Life Cycle. Design concepts relate to different stages of the product life cycle but should be applied in the early design stages. Therefore, it affects various stages of the design life cycle such as design review, production, application, and support. In other words, information from these stages of production must be in the hands of the design team during the design of the product. At this stage, the product is simulated under actual usage conditions and sufficient information is obtained about the behavior of the product. The comparison of the design life cycle is demonstrated in Table 3.

The main purpose of design in the oil and gas industry is to meet the needs of stakeholders and at the same time reduce costs as much as possible. Shorter life cycles result in shorter time for businesses to enter the market. Conducting studies in the early stages of product development can provide design choice.

4.4. Fault Analysis. Industrial coatings play a very important role in protecting assets against deterioration on the one hand and projecting the brand and image of a business on the other. Plants, machinery and equipment, chimneys, and tanks in poor condition reflect the brand image poorly. For many industrial businesses, coatings are essential materials that require regular maintenance. Effective inspections and fault analysis and condition assessments are needed to keep chimneys, tanks, and pits in good condition. The comparison of fault analysis is demonstrated in Table 4.

Table 1: Comparison of pipeline integrity tests.

No. of inputs	OGERS	DSMEC	OSIOT	PSPA	GHSEM
100	49.53	54.49	88.94	74.73	93.68
200	48.24	53.74	84.32	71.33	93.58
300	48.49	53.77	84.32	71.69	93.51
400	47.71	53.28	81.24	69.54	93.42
500	47.19	52.92	78.93	68.02	93.34
600	46.67	52.56	76.62	66.50	93.25
700	46.15	52.20	74.31	64.98	93.17

Table 2: Comparison of design review and inspection.

No. of inputs	OGERS	DSMEC	OSIOT	PSPA	GHSEM
100	48.62	54.59	84.79	72.88	93.47
200	48.54	54.68	84.99	72.75	93.43
300	48.55	54.81	85.25	72.73	93.40
400	48.90	55.23	85.88	73.16	93.38
500	48.87	55.34	86.11	73.09	93.35
600	48.95	55.55	86.46	73.17	93.32
700	49.04	55.75	86.82	73.25	93.29

Table 3: Comparison of the design life cycle.

No. of inputs	OGERS	DSMEC	OSIOT	PSPA	GHSEM
100	48.67	53.43	85.61	71.41	93.69
200	48.17	53.43	84.52	71.15	93.58
300	47.42	52.60	83.38	70.58	93.52
400	47.42	53.33	83.74	71.72	93.47
500	46.80	52.92	82.63	71.31	93.39
600	46.35	52.80	81.95	71.34	93.31
700	45.90	52.69	81.28	71.38	93.24

Table 4: Comparison of fault analysis.

No. of inputs	OGERS	DSMEC	OSIOT	PSPA	GHSEM
100	48.47	54.44	85.27	72.74	93.43
200	48.75	54.84	85.91	72.98	93.40
300	48.03	54.27	85.33	72.33	93.38
400	47.98	54.35	85.56	72.27	93.35
500	47.76	54.26	85.59	72.07	93.33
600	47.54	54.18	85.62	71.86	93.30
700	47.32	54.09	85.65	71.66	93.28

4.5. Paint Inspections. A coating survey and paint test are done to gather information on how well the coating is performing, where there are weak spots and if any maintenance or repairs are needed to prevent corrosion and deterioration. Coating and paint controls ensure that safety gaps are identified and maintenance budgets are used only where necessary. The comparison of paint inspection is demonstrated in Table 5.

Table 5: Comparison of paint inspection.

No. of inputs	OGERS	DSMEC	OSIOT	PSPA	GHSEM
100	56.96	44.90	83.12	70.25	95.69
200	58.62	50.76	76.28	76.43	95.58
300	59.07	49.62	74.99	77.92	95.52
400	54.38	50.76	72.85	81.16	95.47
500	53.99	51.64	74.42	80.44	95.43
600	54.15	52.84	76.04	80.31	95.40
700	54.89	54.49	77.84	81.58	95.38

Coating and paint inspections are useful in predicting future maintenance needs and spotting current or potential problems. Coatings and paints need to be strong and effective to keep assets structurally sound and perform well. In a cutoff point, the proposed model achieved 93.42% of pipeline integrity test results, 93.38% of design review and inspections, 93.47% of design life cycle, 93.35% of fault analysis, and 95.47% of paint inspection results.

5. Conclusion

The main reason for this is, most often, a solar photovoltaic cell that is completely discharged within a few days. Trying to collect it in this case will not lead to a positive result. A similar problem is the result of a decrease in the density of the electrolyte poured into the solar photovoltaic cell banks. After all, this liquid is, in fact, a catalyst for the electrochemical process; without it, the solar photovoltaic cell is a plastic package that will not work. It consists of approximately 35% to 65%; this liquid has a specific density, which can decrease and increase depending on the charge. In this case, the density of the resulting solution is rarely checked. At the same time, when the amount of distilled water is sufficient, during recharging, the electrolyte boils with this liquid, which leads to a decrease in its density. Sooner or later, this indicator drops below a critical level and the starting solar panels will no longer work. In this case, it is necessary to increase this parameter of the solution in the solar photovoltaic cell, which will restore its performance.

Data Availability

The data used to support the findings of this study are included within the article. Further data or information is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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